# Impacts of health condition on economic growth in the 1990s: an analysis for the Brazilian states[1]

*Kenya Noronha, Lízia de Figueiredo, Mônica Viegas Andrade*

## 1 – Introduction

In the last few decades, Brazil has suffered changes in its demographic structure due to decreases in fertility rates and to a lesser extent in mortality rates which contribute to accelerate the aging process of the population. Between 1950 and 2000 the proportion of elderly people increased from 3% to 5% and according to projections of the population this percentage will reach 12% in 2030 (CELADE 2002). As a result, we can observe changes in the morbidity and mortality profile of the Brazilian population, such as increases in the prevalence of chronic-degenerative illnesses followed by decreases in the prevalence of infecto-contagious diseases (IDB 2005, IBGE 2001).

Since this process has occurred unevenly across Brazilian regions due to differences in the level of socioeconomic development, different epidemiological profiles are coexisting in this country. In the South and Southeast regions which socioeconomic indicators are similar to the developed countries, the prevalence of chronic diseases is predominant. On the other hand, in the poorest regions located mainly at North and Northeast of the country, the prevalence of infecto-contagious and parasitic illnesses, undernourishment and infant mortality rates are still high despite their decreasing trends between 1990 and 2003 (IDB 2005).

[1] The authors would like to thank FAPEMIG (Research Support Foundation of Minas Gerais) for its financial support to this research, and the William and Flora Hewlett Foundation for the support to the Graduate Program of Demography at CEDEPLAR (Center for Development and Regional Planning)".

The main goal of this study is to assess the relationship between health and economic growth in Brazil during the last decade – the states of the federation being considered as units of analysis. The effects of health on economic growth may occur through three mechanisms: 1) directly through the relationship between health status and individual earnings; 2) indirectly through the effect of health on the level of education; 3) through the health externalities.[2]

Health status affects the work productivity; number of working hours supply and the decision to participate in the labor force. The better the health status the higher the capacity to work and earnings of the individuals. In this sense, poor health status causes considerable losses of individual income (Luft 1975, Kassouf 1999, Alves and Andrade 2003, Murrugarra and Valdivia 1999, Ivaschenko 2003). These losses affect both individual as well as society wellbeing contributing to decrease the level of wealth and to worse the income distribution in the country (Noronha 2005).

Health Status can also have an indirect effect on economic growth through its effects on the level of education as it affects the attendance to the classes and the capacity of learning and concentration of the individuals (Cutler & Lreras-Muney 2006). The relationship between health condition and human capital stock can even be analyzed by taking into account the dynamic aspect of this relationship. The depreciation rate of human capital stock would be directly associated with the health status level of the population as the individuals' health stock decreases with their lifetime. The depreciation rate may be higher or lower depending on the technological level of the society (which would allow the introduction of new kinds of medical assistance and medicines), access to health care services, demographic profile (age and sex distribution), living and consumption habits and violence level, among others. Societies with higher depreciation rate (for example, high level of mortality) tend to

[2] See Sachs (2001) for a more detailed discussion about the macroeconomics impact of health.

show a lower level of investment in education as the cost of such investment may not be offset. From the individual perspective, a worst health status would also affect the family educational expenditures as it can decrease the productivity of hours devoted to the education and its return rates. In the face of a lower life expectancy, individuals tend to decide for a lower investment in education (Falcão e Soares 2005, Cutler& Lreras-Muney 2006).

A third mechanism through which health affects economic growth is associated with the presence of externalities in health to the extent that the individual health level not only depends on one's own health but also the society's average health condition. These are called diffuse externalities (Andrade and Lisboa 2000). This is the case of contagious diseases and diseases avoidable by basic sanitation and vaccination. Such externalities have health effects on economic growth and it is more evident in less developed countries where health and poverty are closely related. African countries with high AIDS incidence show how the existence of externalities in health may undermine economic growth. Though indirectly, such externalities may also affect business investment decisions (Sachs 2001). Thus, health effect on growth models can also be indirectly captured through the physical capital of the economy.

The impact of the health on the investment can also be observed through decreases on the individual capacity of save (Sachs 2001). If the technological progress rate of some region depend on the research effort (income destined to the R&D), lower income level due to the direct negative effects of health status would be worst intensifying the income inequalities observed among regions (Howitt 2005).

Only recently health condition has been given relevance as a possible determinant of economic growth.[3] The main difficult is related to the existence of

[3] Several empirical works found a positive effect of average population health on economic growth rates (Fogel 1994, Knowles e Owen 1995, Barro 1996, Bhargava *et alli,* 2001, Bloom *et all* 2001,

comparable health measures among economies which are able to capture the multiple health condition dimensions of the population. There are few studies analyzing this relationship considering Brazilian data (Mayer et al 2000, Mora and Barona 2000, Cermeno 2000, Mayer 2000). The results suggest an effect of health on economic growth in Brazil. However, they are not conclusive and depend on the health measure utilized. In this paper, we used several indicators as proxy for health status: infant mortality rate and proportion of deaths by selected causes such as vascular diseases, diabetes, cancer, transmissible illnesses, AIDS, homicides and badly-defined causes. Those measures reflect different epidemiologic and morbidity profiles experienced among the Brazilian states.

The main results found in this paper are in accordance to that one predicted by the literature. The better the population health conditions the higher the economic growth independently of the health measure analyzed.

This paper is divided into five sections besides this introduction. The next section shows the estimation procedures and the dependent and independent variables. Section 3 presents the results and the section 4 the discussion.

**2 – Method**

*Econometric Model and Estimation Procedures*

This paper investigates the relationship between health and (transition) growth rate for the Brazilian states. Based on the amplified Solow's model, we accepted the hypothesis that changes in the main parameters of the economy – as for example

---

Sachs 2001). However, Zon & Muysken (1997) has found a negative relationship between both variables. According to the model proposed by Baumol, the population health condition may have several effects on economic growth: on the one hand, it may positively affect economic growth, as it increases the society's human capital; on the other hand, as it is a nonproductive activity, it competes with productive sectors in the economy in the allocation of scarce resources which determines a negative relation with the economic growth (Zon & Muysken 1997).

investment rates and fertility rates, temporally affect economic growth rates. However, in the long term period, economic growth rates would only depend on the technological progress. The parameters of the economy, in turn, would determine the level of per capita income in the long-term period (Barro 1991). Our study is restricted to the period from 1991 to 2000 due to constrained compatible and reliable data on health condition for all Brazilian states.

Let i and t be the subscripts concerning the federative units and years respectively. Thus, the econometric model can be specified as follows (Barro 1991):

$$\gamma_{it} = \beta_1 + \beta_2 y_{it-1} + \beta_3 \, HEALTH_{it-1} + \Sigma_t \beta_t \, year + \Sigma_s \beta_s \; Region + \Sigma_j \beta_j X_{jit-1} + \varepsilon_{it} \qquad (1)$$

where:

$\gamma_{it}$ = the growth rate of real GDP per capita;

$\beta_k$ = the estimated parameters for the k variables;

$\beta_t$ = the estimated parameters for the t years, with t varying from 1991 to 2000, being 1995 the reference year;

$\beta_s$ = the estimated parameters for the s regions, being s equal to the North, Northeast, Southeast – except for São Paulo -, Center-West, and South regions, being São Paulo the reference region;

$y_{it-1}$ = real GDP per capita with a one-year gap;

$HEALTH_{it-1}$ = average health condition of the population;

$X_{jit-1}$ = socioeconomic and demographic variables;

$\varepsilon_{it}$ = random shocks.

Our main objective is to test whether the coefficient of the HEALTH variable is statistically higher than zero, i. e.:

$H_0$: $\beta_3 > 0$

$H_1$: $\beta_3 \leq 0$

The model specified in (1) assumes that the intercept may be different for the distinct years in the sample and Brazilian States, which would lead us to estimate the panel model. Two different determinants led us to choose the panel model: a) To increase the number of observations and attenuate the omission variables problem; b) to control the model by means of economic cycle effects, which thus became filtered by the year dummies variables.

The estimation procedure is stepwise-typed, i. e., when estimating the model the least statistically significant variable will be removed so that only variables whose coefficients are different from zero to at least 10% of significance can be found. This procedure does not include time dummies and dummies for the Brazilian states either.

Three tests were accomplished in this paper: one for the normality of residues, one for detecting autocorrelation, and another for the heteroscedasticity. The test for normality of residues was based on a combination of the skewness and kurtosis tests. The result led us to accept the hypothesis that the residues are normally distributed at 1% of significance. In order to detect heteroscedasticity, the White test (1983) was performed and in case heteroscedasticity is present we use the White procedure to correct it. We tested the presence of autocorrelation, by comparing the coefficient $\rho$ estimated by the Prais-Winsten method with the critical values from the Durbin-Watson table. The estimated coefficient was located in the indecision region. The model was corrected by the Prais-Winsten method and no significant discrepancies with the results estimated by the least squares method were found.

*Dependent and Independent Variables*

The dependent variable of the model is the growth rate of real GDP per capita measured at market price (in thousand dollars) and at fixed dollar in 1990[4]. The data

[4] In order to obtain the deflated GDP for each state – measured based on the 1990 dollar – , we have estimated the series of the Brazilian real GDP. Afterwards, we have multiplied the participation of

source is the regional accounts accomplished by IBGE (the Brazilian census agency), which provides nominal GDP for each federation unit (IBGE, *Diretoria de Pesquisas, Departamento de Contas Nacionais, Contas Regionais do Brasil 1985-2000)*. The analysis encompasses all the Brazilian states in 1991-2000[5]. Choosing this period was mainly due to restricted compatible and reliable data on health condition for all Brazilian states. Only in the 1990s, with the creation of the Datasus, it is observed a more transparent and centered health information system in Brazil. Using data for previous periods with annual periodicity would not be possible. Additionally, as the decade of 1990 is a period of remarkable structural changes in the health area and such changes are not uniformly observed for all states, using a panel for 10 years – which takes account of the existing diversity among the Brazilian states – seems to provide a useful set of information to start understanding the relation between growth and health in Brazil.

In order to measure the average health status of the population, we used several indicators as proxy. The first is infant mortality rate. Using data from IBGE (2002), this rate is defined as the ratio between the number of deaths among children under a year of age and the number of live-born children. The relationship between infant mortality and economic growth rate is expected to be negative, i. e., the lower the infant mortality rate, the healthier the population, and the higher the economic

---

nominal GDP per capita of each FU by the estimated Brazilian real GDP. Such a procedure allowed us to deflate the GDP of each state, in relation to variations in domestic prices and the (foreign) dollar inflation. The Brazilian nominal GDP in 1990, measured in dollars, and the real GDP growth rates for 1991-2000 were taken from *Conjuntura Econômica* (2000).

[5] The Federal District was excluded as its economic activity is based on the public services which it makes difficult to test the mechanisms of market predicted by the economic growth models.

growth. [6] Besides the infant mortality rate, we also test the effect of the proportion of deaths by the following causes: vascular diseases, diabetes, cancer, transmissible illnesses, AIDS, homicides and badly-defined causes. The proportion of deaths is estimated for the period between 1990 and 1999. The source of data is the DATASUS (IDB-2005). The use of several health measures allowed us to consider the effect of the differences in the morbidity and mortality profiles observed among the Brazilian states on the economic growth rate as well as to test the robustness of the results.

The relation between economic growth and health is endogenous, i. e., it is simultaneously determined by the model. Using instrumental variables, which are related to health status but not to the growth rate of real GDP per capita, is a way of controlling endogeneity. The variable itself – with a time lag in relation to the dependent variable – is commonly the instrument used in this kind of analysis. For this reason, the health measures used in this paper were included with a one-year gap in relation the growth rate of real GDP per capita in this model.

The other independent variables of our model are proxies of the equilibrium income per capita determinants. The choice of these variables was based on the international empirical literature, constrained by data availability though. Such variables included a set of socioeconomic and demographic measures. Table 1 shows each of these variables as well as their data source and description. All variables were included in the model with a one-year gap in relation to the growth rate of real GDP per capita.

**Table 1**

[6] The infant mortality rate decreased in all states during the 1990s. The Northeast shows the highest averages, especially for Alagoas (81.76 deaths per thousand live-born children). The ratio between the smallest value and the highest value – which correspond to the infant mortality rate in the end and the beginning of the period respectively – shows a reduction of about 33% of such an indicator from 1990 to 1999. The highest decrease occurred in Roraima (53.66%) and the smallest, in Amazonas (27.75%).

## Description of Independent Variables

| Variable | Data source | Description | |
|---|---|---|---|
| *Gini Coefficient* | PNADs for 90, 92, 93, 95-99.<br><br>Census of 1991 and 2000.<br><br>PNAD was accomplished in 1994 | Estimated based on household income per capita. | A simple interpolation was determined for 1994.<br><br>North region: PNAD does not take the urban area into account. Based on the 1991 and 2000 censuses, we estimated each variable for urban and rural areas and then the rural area only. We obtained the ratio between the variable estimated for the rural area and the variable estimated for both localities for each census year. We interpolated this ratio and applied the value found the correspondent variable estimated based on the PNADs. |
| *Average years of study of working age population (WAP)* | | Full years of study | |
| *Age Structure* | | Proportion of WAP in relation to total population. (We also tested the dependence ratio which is the proportion of individuals under age 14 and over 64 in relation to the WAP. The results are quite similar) | |
| *Urbanization Rate* | | Proportion of individuals living in urban areas | North region: simple interpolation using the censuses of 1991 and 2000. |
| *Migration rate (refers to urban residents only)* | | Net migration rate = migratory balance/observed population.<br><br>Migratory balance = Immigrants – Emigrants | Immigrant = individual not residing in the federation unit – FU – in the previous five years and living there in the survey year.<br>Emigrant = individual reporting the place of residence in the previous five years as he/she did not live in the FU on that date.<br>For 1994: simple interpolation |
| *Demographic density* | DATASUS | Population divided by the FU territorial extension | |
| *Fertility rate* | Sawyer et al, (1999) | These rates were estimated for 1991, 1995, 2000, 2005, 2010, 2015, and 2020.<br>We used the 1991 information for 1991-1994 and the 1995 fertility rates for 1995-2000. | |
| *Physical capital stock* | Statistical Yearbook (several years) | Measured as the total electric energy consumption | |
| *Economic distance* | Statistical Yearbook (2000) and regional accounts (1985-2000) | $D_j^t = \sum_i d_{ij}^t \frac{PIB_i^t}{PIB_{total}^t}$ ,where $d_{ij}$ is the distance from the capital of the state j in relation to the other state capitals. $D_j$ is estimated for each FU for each year t. | |
| *Participation of industry in the GDP of FU* | Statistical Yearbook (2000) | | |
| *Participation of services in the GDP of each FU* | | | |

Additionally, we included income per capita (y) in the beginning of each period, in order to test the presence of conditional convergence (convergence $\beta$) of economic growth and a set of dummy variables for each region, the state of São Paulo, and for each year.

## 3 – Results

This paper has two main objectives. Firstly, we verify whether health condition directly impacted the Brazilian economic growth during the 1990s. Secondly, we attempted to evaluate the indirect effect of health condition on economic growth by means of its relation with education. The following exercises were accomplished. Firstly, we estimated the model by including a variable measuring the average health condition of the population in order to verify its direct effect on economic growth (subsection 3.1). Secondly, we let the infant mortality rate (a proxy of population health condition) and the education variable to interact with each other in order to evaluate whether health had any indirect effect on the growth of GDP per capita (subsection 3.2). For each specification, we estimated a model taking account all variables aforementioned (table 1) and a parsimonious model including the statistically significant variables at least at 10%.

### *3.1 The direct effect of health condition on economic growth*

Table 2 shows results for the model that includes all variables and the parsimonious model 1. We also present the results of the base model, which is obtained from the estimation of the parsimonious model 1 without the infant mortality rate. This model allows us to verify what happens with the education effect on economic growth when the proxy variable of health condition is omitted. The results for the two models estimated with the infant mortality rate are quite similar and, in general, they present the expected sign. The main variables that explain the economic growth of the Brazilian states in 1990's are the human capital level (the infant mortality rate and level of schooling), investment in physical capital (measured as the rate electric energy variation), fertility rate, population density, industrial participation in the GDP and initial per capita income. Analyzing the parsimonious model 1, we noticed that a unity reduction in the initial income per capita increases

9.31% the growth rate of GDP per capita. This means that, by controlling the steady state level, the smaller the initial output level, the higher the rate of economic growth.

**Table 2**

**Direct effect of health condition on economic growth**

| Independent Variables | *First Specification of the Model: without interaction terms* | | | | *Base Model: without health Variable* | |
|---|---|---|---|---|---|---|
| | ***All Variables*** | | ***Parsimonious Model 1*** | | | |
| Initial GDP | -0.0970 | *** | -0.0931 | *** | -0.0869 | *** |
| **Variation rate of electric energy** | 0.0489 | ** | 0.0450 | *** | 0.0448 | *** |
| **Fertility rate** | 0.0318 | ns | 0.0319 | ** | 0.0230 | * |
| Gini coefficient | -0.1170 | ns | | | | |
| WAP proportion in relation to total population | -0.0009 | ns | | | | |
| **Education** | 0.0341 | * | 0.0393 | *** | 0.0414 | *** |
| Urbanization rate | 0.0014 | ns | | | | |
| Population density | 0.0002 | * | 0.0003 | *** | 0.0002 | ** |
| **Economic distance** | 0.0000 | ns | | | | |
| Migration rate (urban residents) | -0.0031 | * | | | | |
| Industrial participation in state GDP | 0.0031 | *** | 0.0030 | *** | 0.0028 | *** |
| Services participation in state GDP | 0.0003 | ns | | | | |
| **Infant Mortality Rate** | **-0.0013** | * | **-0.0011** | * | | |
| Southeast (except for São Paulo) | -0.0615 | ** | -0.0754 | *** | -0.0690 | *** |
| North | -0.0981 | * | -0.1444 | *** | -0.1375 | *** |
| South | -0.0557 | ** | -0.0716 | *** | -0.0677 | *** |
| Center-West | -0.0766 | ** | -0.0875 | *** | -0.0833 | *** |
| Northeast | -0.1267 | ** | -0.1557 | *** | -0.1704 | *** |
| 1991 | -0.0305 | ns | -0.0348 | ns | -0.0403 | * |
| 1992 | -0.0562 | ** | -0.0676 | *** | -0.0690 | *** |
| 1993 | -0.0030 | ns | 0.0002 | ns | 0.0014 | ns |
| 1994 (reference year: 1995) | 0.0075 | ns | 0.0085 | ns | 0.0116 | ns |
| 1996 | -0.0038 | ns | -0.0007 | ns | 0.0008 | ns |
| 1997 | -0.0159 | ns | -0.0082 | ns | -0.0053 | ns |
| 1998 | -0.0514 | ** | -0.0444 | ** | -0.0398 | ** |
| 1999 | -0.0400 | * | -0.0328 | * | -0.0270 | ns |
| 2000 | -0.0145 | ns | -0.0086 | ns | -0.0011 | ns |
| *Constant* | 0.0099 | ns | 0.0121 | ns | -0.0228 | ns |
| **F** | **4.38** | | **4.70** | | **4.91** | |
| *Prob>F* | **0.0000** | | **0.0000** | | **0.0000** | |
| **R2** | **0.3488** | | **0.3241** | | **0.3161** | |
| **Root MSE** | **0.0597** | | **0.0601** | | **0.0603** | |
| **N** | **260** | | **260** | | **260** | |

[ns] non-significant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

The estimated coefficient of mortality was negative, indicating that a worse health condition is harmful to the economic growth. A unity increase in this variable decreases 0.11% the economic growth rate. Also, it is observed the coefficient of the initial per capita income increases (in absolute terms) in the parsimonious model 1 in respect to the model base, indicating a higher rhythm of convergence beta among the Brazilian states when health status variable is consider in the model.

The average education effect of the working-age population was predictable. The higher the educational level the higher the economic growth. An additional year in education increases 3.93% the growth rate. Taking the base model into account, we observed that the education effect did not change when the infant mortality was omitted.

The variables with positive effect on the growth rate were population density, investment in physical capital, industrial participation in GDP, and fertility rate. *Ceteris paribus*, localities with higher number of people per square meter showed a higher growth rate given that the population density coefficient was positive and significant at 1%. Such result suggests that the agglomeration did not restrict growth, indicating a process of wealth concentration. The positive sign of the population density coefficient also suggests that the frontiers – which have played an important role in diminishing regional disparities – seemed to have lost dynamism during the 1990s.

In the same way, increased investment in physical capital and industrial participation in GDP have contributed to increase the rate of economic growth. A 1% increase in the growth rate of electric energy would increase 4.5% the growth rate of GDP per capita, *ceteris paribus*. The variables industrial participation in GDP and participation of services in GDP were included in order to test whether the economies of scale resulting from the forward and backward effects in these sectors had an impact on growth rate of GDP per capita, as predicted in the literature of the new economic geography (Fujita, Krugman e Venables 1999, Figueirêdo 2002). Despite the increased participation of services in GDP, mainly in the second half of the 90s, the industrial sector was still an important variable as far as per capita income growth is concerned. Our results suggest that, *ceteris paribus*, an increased participation of the industrial sector would increase by 0.3% the growth rate of GDP per capita.

A slightly intuitive result is concerned with the effect of fertility rate. We observed that higher fertility rates have contributed to economic growth, as their coefficient was positive and significant at 5%. In order to verify what exactly fertility rate is measuring in our analysis, we first estimated the economic growth model considering only the fertility rate as independent variable and later we included each independent variable in the model. When we consider only fertility rate, its effect on economic growth is as expected: the higher the fertility rate the lower the economic growth. The effect of fertility rate becomes positive after including the following variables "economic distance", "dummies of region", "Industrial participation in state GDP" or "Services participation in state GDP". As those independent variables are related to the level of socioeconomic development of the Brazilian states, the effect of fertility rate, after controlling for them, no more reflect the level of development or poverty of the locality. In a macroeconomic approach, the fertility rate can be measuring the higher potential of economic growth in societies which demographic transition is in their initial stage. Its effect can be compared to that one of the initial income per capita in the economic growth model. Another possible explanation can be the presence of multicolinearity existing between fertility rate and the aforementioned independent variables.

*Effect of the proportion of deaths by selected causes*

We individually test the effect of the proportion of deaths by vascular diseases, diabetes, transmissible illnesses, cancer, AIDS, homicides and badly-defined causes. These indicators reflect the different epidemiologic and morbidity profiles experienced by the Brazilian states. Proportion of deaths by vascular diseases, cancer and diabetes are associated to a higher proportion of elderly people indicating better life conditions and health services access. On the other hand, the deaths by transmissible illnesses, AIDS, homicides and badly-defined causes are related to the level of poverty and development of the society as well as to worse health care access.

The results are in accordance to the previous one. The worst the health conditions of the population the lower the economic growth. The model considering the proportion of deaths by vascular diseases, diabetes or cancer had a positive effect of health on the economic growth rate. On the other hand, the effect of the proportion of deaths by transmissible illnesses is negative. The effect of the proportion of deaths by AIDS, homicides and badly-defined causes on economic growth rates is not significant (Tables 3a and 3b).

## Table 3a

## Direct effect of health status on economic growth

## Health Measure: Proportion of deaths by Selected Causes (Parsimonious Model)

| Independent Variables | Vascular | | Diabetes | | Cancer | |
|---|---|---|---|---|---|---|
| Initial GDP | -0.0942 | *** | -0.0684 | *** | -0.1078 | *** |
| Δ electric energy rate | 0.0485 | *** | 0.0474 | ** | 0.0361 | *** |
| Fertility rate | 0.0369 | ** | | | 0.0297 | ** |
| Education | 0.0446 | *** | | | 0.0305 | ** |
| Urban. rate | | | 0.0021 | *** | | |
| Pop. density | 0.0002 | *** | | | 0.0003 | *** |
| Migration rate | | | -0.0039 | ** | | |
| % Industrial in GDP | 0.0034 | *** | 0.0016 | ** | 0.0033 | *** |
| **Heath Status** | 0.0040 | ** | 0.0196 | *** | 0.0118 | *** |
| Southeast (except SP) | -0.0671 | *** | -0.0504 | ** | -0.0781 | *** |
| North | -0.1033 | *** | -0.0799 | *** | -0.1367 | *** |
| South | -0.0780 | *** | -0.0430 | ** | -0.1080 | *** |
| Center-West | -0.0695 | *** | -0.0749 | *** | -0.0863 | *** |
| Northeast | -0.1451 | *** | -0.1500 | *** | -0.1765 | *** |
| 1991 | -0.0465 | ** | -0.0211 | ns | -0.0384 | * |
| 1992 | -0.0746 | *** | -0.0600 | *** | -0.0764 | *** |
| 1993 | -0.0082 | ns | 0.0159 | ns | -0.0077 | ns |
| 1994 | 0.0029 | ns | 0.0258 | ns | 0.0089 | ns |
| 1996 | 0.0002 | ns | -0.0051 | ns | 0.0031 | ns |
| 1997 | -0.0049 | ns | -0.0066 | ns | -0.0047 | ns |
| 1998 | -0.0416 | ** | -0.0435 | ** | -0.0418 | ** |
| 1999 | -0.0287 | ns | -0.0227 | ns | -0.0270 | ns |
| 2000 | -0.0046 | ns | 0.0070 | ns | -0.0058 | ns |
| Constant | -0.1848 | * | 0.0350 | ns | -0.0493 | ns |
| F | 5.03 | *** | 5.28 | *** | 5.79 | *** |
| R2 | 0.33 | | 0.33 | | 0.35 | |
| Root MSE | 0.06 | | 0.06 | | 0.06 | |
| N | 260 | | 260 | | 260 | |

[ns] nonsignificant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

## Table 3b

## Direct effect of health status on economic growth

## Health Measure: Proportion of deaths by Selected Causes (Parsimonious Model)

| Independent Variables | Transmissible | | AIDS | | Homicides | | Badly-defined | |
|---|---|---|---|---|---|---|---|---|
| Initial GDP | -0.0857 | *** | -0.0757 | *** | -0.0757 | *** | -0.0757 | *** |
| Δ electric energy rate | 0.0386 | ** | 0.0441 | ** | 0.0441 | ** | 0.0441 | ** |
| Fertility rate | 0.0269 | * | | | | | | |
| Education | 0.0510 | *** | 0.0324 | *** | 0.0324 | *** | 0.0324 | *** |
| Urban. rate | | | | | | | | |
| Pop. density | 0.0002 | ** | 0.0002 | * | 0.0002 | ** | 0.0002 | * |
| Migration rate | | | | | | | | |
| % Industrial in GDP | 0.0024 | *** | 0.0024 | *** | 0.0024 | *** | 0.0024 | *** |
| **Heath Status** | -0.0060 | * | - | ns | - | ns | - | ns |
| Southeast (except SP) | -0.0812 | *** | -0.0574 | *** | -0.0574 | *** | -0.0574 | *** |
| North | -0.1315 | *** | -0.1001 | *** | -0.1001 | *** | -0.1001 | *** |
| South | -0.0890 | *** | -0.0578 | *** | -0.0578 | *** | -0.0578 | *** |
| Center-West | -0.0864 | *** | -0.0678 | *** | -0.0678 | *** | -0.0678 | *** |
| Northeast | -0.1757 | *** | -0.1342 | *** | -0.1342 | *** | -0.1342 | *** |
| 1991 | -0.0312 | ns | -0.0303 | ns | -0.0303 | ns | -0.0303 | ns |
| 1992 | -0.0638 | *** | -0.0621 | *** | -0.0621 | *** | -0.0621 | *** |
| 1993 | 0.0029 | ns | 0.0141 | ns | 0.0141 | ns | 0.0141 | ns |
| 1994 | 0.0123 | ns | 0.0242 | ns | 0.0242 | ns | 0.0242 | ns |
| 1996 | -0.0014 | ns | 0.0008 | ns | 0.0008 | ns | 0.0008 | ns |
| 1997 | -0.0136 | ns | -0.0037 | ns | -0.0037 | ns | -0.0037 | ns |
| 1998 | -0.0532 | ** | -0.0379 | ** | -0.0379 | * | -0.0379 | * |
| 1999 | -0.0420 | ** | -0.0232 | ns | -0.0232 | ns | -0.0232 | ns |
| 2000 | -0.0208 | ns | 0.0051 | ns | 0.0051 | ns | 0.0051 | ns |
| Constant | -0.0126 | ns | 0.0491 | ns | 0.0491 | ns | 0.0491 | ns |
| F | 5.15 | *** | 4.99 | *** | 4.99 | *** | 4.99 | *** |
| R2 | 0.33 | | 0.31 | | 0.31 | | 0.31 | |
| Root MSE | 0.06 | | 0.06 | | 0.06 | | 0.06 | |
| N | 260 | | 260 | | 260 | | 260 | |

[ns] nonsignificant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

We also specify the model considering jointly all health status variables aforementioned besides the infant mortality rate. In order to get a more parsimonious model, we removed the non-significant variables keeping only those which significance level is equal or lesser 10%. Analyzing the final parsimonious model 2 in table 4, only the variables "proportion of deaths by transmissible illnesses" and "proportion of deaths by cancer" are significant and present the expected signal, suggesting robustness of the results found for infant mortality rate. The localities with worse health conditions experienced the lower economic growth rates during the analyzed period.

Another exercise was including in the parsimonious model 1 (specified in table 2) the measures of health (proportion of deaths by selected causes) where the correlation with the infant mortality rate is lower in order to consider different dimensions of the average health of the population and to prevent multicolinearity problems. Those variables are proportion of deaths by transmissible illnesses, diabetes and homicides which correlation with infant mortality rate is as lower than 0.25.

The results, showed in table 5 (Parsimonious Model 4), are in accordance to the previous one: the economic growth rate is positively related with the average health level of the population. Infant mortality rate and the proportion of deaths by transmissible illnesses have a negative effect on economic growth, whereas the proportion of deaths by diabetes has a positive effect. The proportion of deaths by homicides is not significant (Parsimonious Model 3).

## Table 4

## Direct Effect of health status on economic growth considering jointly different health measures

| Variables | All Variables | | Parsimonious Model 2 | |
|---|---|---|---|---|
| Initial GDP | -0.1195 | *** | -0.1076 | *** |
| **Variation rate of electric energy** | 0.0308 | * | 0.0289 | ** |
| **Fertility rate** | 0.0511 | ** | 0.0343 | ** |
| Gini coefficient | -0.0728 | ns | | |
| WAP proportion in relation to total population | 0.3344 | ns | | |
| **Education** | 0.0243 | ns | 0.0404 | *** |
| Urbanization rate | 0.0016 | ns | | |
| Population density | 0.0002 | ns | 0.0003 | *** |
| **Economic distance** | 0.0000 | ns | | |
| Migration rate (urban residents) | -0.0028 | ns | | |
| Industrial participation in state GDP | 0.0036 | ** | 0.0029 | *** |
| Services participation in state GDP | 0.0009 | ns | | |
| **Infant Mortality Rate** | **-0.0010** | **ns** | | |
| **Vascular Diseases** | **-0.0007** | **ns** | | |
| **Transmissible diseases** | **-0.0052** | **ns** | **-0.0065** | ** |
| **Aids** | **-0.0048** | **ns** | | |
| **Diabetes** | **0.0173** | **ns** | | |
| **Homicide** | **0.0040** | **ns** | | |
| **Badly-defined** | **0.0011** | **ns** | | |
| **Cancer** | **0.0135** | *** | **0.0123** | *** |
| Southeast (except for São Paulo) | -0.0988 | *** | -0.0918 | *** |
| North | -0.1253 | ** | -0.1302 | *** |
| South | -0.1214 | *** | -0.1332 | *** |
| Center-West | -0.1063 | *** | -0.0898 | *** |
| Northeast | -0.1868 | *** | -0.1825 | *** |
| 1991 | -0.0239 | ns | -0.0284 | ns |
| 1992 | -0.0647 | *** | -0.0711 | *** |
| 1993 | -0.0165 | ns | -0.0065 | ns |
| 1994 | -0.0002 | ns | 0.0095 | ns |
| 1996 | -0.0067 | ns | 0.0008 | ns |
| 1997 | -0.0275 | ns | -0.0138 | ns |
| 1998 | -0.0744 | *** | -0.0565 | *** |
| 1999 | -0.0634 | *** | -0.0433 | ** |
| 2000 | -0.0526 | ** | -0.0275 | ns |
| Constant | -0.3171 | ns | -0.0395 | ns |
| **F** | **4.890** | *** | **6.330** | *** |
| **R2** | **0.400** | | **0.373** | |
| **Root MSE** | **0.058** | | **0.058** | |
| **N** | **260** | | **260** | |

[ns] non-significant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

**Table 5**

**Direct Effect of Health Status on Economic Growth considering as health proxy measures infant mortality rate, proportion of deaths by transmissible diseases, diabetes and homicides.**

| Variables | Parsimonious Model 1 | | Parsimonious Model 3 | | Parsimonious Model 4 | |
|---|---|---|---|---|---|---|
| Initial GDP | -0.0931 | *** | -0.0894 | *** | -0.0917 | *** |
| **Variation rate of electric energy** | 0.0450 | *** | 0.0386 | ** | 0.0381 | ** |
| **Fertility rate** | 0.0319 | ** | 0.0410 | *** | 0.0422 | *** |
| **Education** | 0.0393 | *** | 0.0483 | *** | 0.0470 | *** |
| Population density | 0.0003 | *** | 0.0002 | * | 0.0002 | * |
| Industrial participation in state GDP | 0.0030 | *** | 0.0023 | ** | 0.0024 | *** |
| **Infant Mortality Rate** | **-0.0011** | * | **-0.0010** | **ns** | **-0.0011** | * |
| **Transmissible diseases** | | | **-0.0065** | ** | **-0.0065** | ** |
| **Diabetes** | | | **0.0183** | ** | **0.0185** | ** |
| **homicides** | | | **-0.0011** | **ns** | | |
| Southeast (except for São Paulo) | -0.0754 | *** | -0.0902 | *** | -0.0931 | *** |
| North | -0.1444 | *** | -0.1403 | *** | -0.1477 | *** |
| South | -0.0716 | *** | -0.0996 | *** | -0.0995 | *** |
| Center-West | -0.0875 | *** | -0.0953 | *** | -0.0992 | *** |
| Northeast | -0.1557 | *** | -0.1722 | *** | -0.1770 | ** |
| 1991 | -0.0348 | ns | -0.0204 | ns | -0.0213 | ns |
| 1992 | -0.0676 | *** | -0.0597 | *** | -0.0613 | *** |
| 1993 | 0.0002 | ns | 0.0028 | ns | 0.0016 | ns |
| 1994 | 0.0085 | ns | 0.0094 | ns | 0.0086 | ns |
| 1996 | -0.0007 | ns | -0.0082 | ns | -0.0080 | ns |
| 1997 | -0.0082 | ns | -0.0224 | ns | -0.0224 | ns |
| 1998 | -0.0444 | ** | -0.0682 | *** | -0.0681 | *** |
| 1999 | -0.0328 | * | -0.0574 | ** | -0.0573 | ** |
| 2000 | -0.0086 | ns | -0.0435 | * | -0.0434 | * |
| Constant | 0.0121 | ns | -0.0120 | ns | -0.0048 | ns |
| **F** | **4.70** | *** | **4.82** | *** | **4.97** | *** |
| **R2** | **0.32** | | **0.35** | | **0.35** | |
| **Root MSE** | **0.06** | | **0.06** | | **0.06** | |
| **N** | **260** | | **260** | | **260** | |

ns non-significant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

*3.2 – The indirect effect of health condition on economic growth*

Table 6 shows results of the model in which infant mortality rate is interacted with average schooling so that we could measure the indirect effects of health condition on economic growth. Full model 5 was obtained by including the interaction terms in the parsimonious model 1, analyzed in the previous subsection.

Here again, the variables non-significant at 10% were excluded so that we could obtain the final parsimonious model 6.

The effects of major variables on the rate of economic growth do not change when the interaction terms are considered in model, and the results of the full model 5 and the parsimonious model 6 are quite similar. When analyzing the parsimonious model 6, we have noticed that the economy showed the conditional beta convergence. Moreover, the major variables affecting the rate of economic growth were average education of the working-aging population, investment in physical capital, fertility rate, population density, industrial participation in GDP, and economic distance. The major change in the results in relation to the previous analysis was concerned with the effect of health condition. After including interaction terms, the direct effect of health became non-significant. The results suggest that health condition affects economic growth indirectly through its relation with the level of human capital investment. Table 6 shows that the net effect of education is given by:

(0.0529 - 0.0003 x infant mortality rate) x education.

This relation showed that education has affected positively the rate of growth when infant mortality rate was less than 176.33. For all the Brazilian states, this rate was lower than this value all over the 1990s. Thus, increased years of study favored the growth rate of real GDP per capita in the period. However, it is worth noting that the net effect of education was lower than its pure effect due to the indirect effect of infant mortality rate.

**Table 6**

**Indirect Effect of Health Status on Economic Growth**

| *Second Especification of the Model: including interaction term* | | | | |
|---|---|---|---|---|
| ***Independent Variables*** | ***Full Model 5*** | | ***Parcimonious model 6*** | |
| Initial GDP | -0.0980 | *** | -0.0973 | *** |
| Variation rate of electric energy | 0.0418 | ** | 0.0427 | *** |
| **Fertility rate** | 0.0286 | * | 0.0305 | ** |
| Education | 0.0586 | *** | 0.0529 | *** |
| **Population density** | 0.0003 | *** | 0.0003 | *** |
| Industrial participation in state GDP | 0.0033 | *** | 0.0032 | *** |
| **Infant Mortality Rate** | 0.0006 | ns | | |
| **Infant Mortality Rate * Education** | -0.0004 | ns | -0.0003 | ** |
| Southeast (except for São Paulo) | -0.0729 | *** | -0.0742 | *** |
| North | -0.1324 | *** | -0.1365 | *** |
| South | -0.0752 | *** | -0.0746 | *** |
| Center-West | -0.0827 | *** | -0.0845 | *** |
| Northeast | -0.1428 | *** | -0.1448 | *** |
| 1991 | -0.0313 | ns | -0.0317 | ns |
| 1992 | -0.0656 | *** | -0.0660 | *** |
| 1993 | 0.0026 | ns | 0.0018 | ns |
| 1994 | 0.0109 | ns | 0.0099 | ns |
| 1996 | 0.0000 | ns | -0.0004 | ns |
| 1997 | -0.0091 | ns | -0.0092 | ns |
| 1998 | -0.0455 | ** | -0.0457 | ** |
| 1999 | -0.0364 | ** | -0.0360 | * |
| 2000 | -0.0146 | ns | -0.0137 | ns |
| Constant | -0.0680 | ns | -0.0416 | ns |
| **N** | **260** | | **260** | |
| **F** | **4.58** | | **4.76** | |
| **Prob>F** | **0.00** | | **0.00** | |
| **R-squared** | **0.33** | | **0.33** | |
| **Root MSE** | **0.06** | | **0.06** | |

[ns] nonsignificant, * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

## 4. Discussion

This paper aimed to estimate the impact of health condition on the growth of income per capita among the Brazilian states during the 1990s. We consider both direct and indirect effects. The direct effect can be verified whether the effects of health on individual earnings are reproduced in the macroeconomic level affecting the level of wealth of the society. The indirect effect of health condition on economic growth is observed due to its relation with education. Improved health condition contributes to reduce the effective depreciation rate of human capital and to increase education stock given the increases in investment return in education. In this way, an indirect positive effect of health condition on economic growth may occur, since a higher investment in education and in other forms of human capital improve the average productivity of the population.

The main results found in this paper show that health affects positively economic growth. A unity decrease in the infant mortality rate contributes to increase the economic growth rate by 0.11%. Among the Brazilian states in the 1990s, the infant mortality rate was reduced in approximately 36% in average (from 50.45 deaths per thousand in 1990 to 32.40 in 1999), which contributed to an increase of 2% in the average rate of economic growth *ceteris paribus*. The Brazilian states with the highest decreases in infant mortality rate (in unity terms) between 1990 and 1999 were those of the Northeast region. For example, the infant mortality rate in Alagoas, Ceará, and Paraíba decreased 35, 31 and 30 units during this period. *Ceteris paribus* those decreases contributed to increase the rate of economic growth by 3.82%, 3.39%, and 3.32%. These percentages are significant when we compare to the economic growth rate observed in the 1990s in the country. According to IPEADATA[7], between 1990 and 2000 the Brazilian GDP per capita increased 9%.

These results highlight the importance of the average health conditions of the population in affecting the level of wealth of the society. The infant mortality rate is an overall measure of the average health level of a population and it is quite sensitive to social policies. It reflects both the health condition of live-born children and that of their parents. This is so because it is associated, on the one hand, with health policies designed to preventive actions for the population treatment and access to health care services; and, on the other hand, with the parental health condition (mainly as for nutrition, living habits, and information on health). The infant mortality rate provides

[7] http://www.ipeadata.gov.br/

– to a certain extent – information on the access of health care services, if we have in mind that most of the deaths of children under a year of age result from avoidable causes that are related to socioeconomic characteristics of their environment and the consumption of preventive health care.

Besides the infant mortality rate, we tested others variables as proxy of the average health status of the population. Even though the infant mortality rate is a synthetic indicator widely used in the literature as proxy for the average health status of the population, it is worthy to present the results estimated using others health measures since health status is a multidimensional concept. The results are in accordance to the previous one. We found a significant and negative effect of health variables that are related to the level of poverty and worst access to the health care services, such as transmissible illnesses. On the other hand, we found a positive and significant effect of health variables, as for example diabetes, cancer and vascular diseases. These illnesses are related with the degree of population aging being positively associated with better health conditions of the locality.

Our results also suggest that the main effect of health on economic growth is indirect through its effects on the level of education. Increases in the average years of schooling of the working-age population contribute to accelerate the economic growth in Brazil. In the 1990s, the average educational gain was 1.12 year, which contributed to increase 4.40% the growth rate (*ceteris paribus*). In this period, the states presenting the highest educational level gains were Acre (1.6), Tocantins (1.51), and Roraima (1.5). The effect of such gains on the rate of economic growth was around 6%.

However, when we include in the model the interaction term (infant mortality rate with education level), we observe that the high infant mortality rates decrease the positive effect of education on the economic growth. Our result strongly differs from that by Knowles and Owen (1995), who obtained a non-significant coefficient for education when they introduced the health proxy in their econometric model. In the present study, not only the education coefficient remained positive and significant when infant mortality rate was introduced among independent variables, but also the major effect of health variable on economic growth occurred indirectly through education. After including interaction term, the direct effect of health became non-significant. Therefore, in Brazil, health status seems to affect economic growth indirectly. Localities presenting higher infant mortality rates tended to show a lower productivity due to smaller investment in education and other forms of human capital, leading to lower educational returns in those regions.

The main fragility of this work is the short period of time. We recognize that this period is insufficient to get more robust considerations concerning the dynamics of the economic growth. However, since we are dealing with panel analysis, we believe such limitation is at least in part lowered being offset by the heterogeneity observed among Brazilian states regarding to the development stages and to the epidemiologic profile. Besides, the effects of health on economic growth found in this paper would be underestimated as long as we are not able to analyze the long-term effects of poor health conditions on economic growth. Individuals who belong to the working-age population today were exposed to the epidemiologic profile existing in Brazil since they were born. This period can vary from 14 until 64 years ago that encompasses very different phases of the epidemiological profile experienced by the Brazilian population. For this reason, extensions of this paper should attempt to take account of indicators that could measure health condition of the population as a whole during their cycle life, specially the portion directly affecting the productivity capacity in the country. In order to perform such analysis it is necessary to take account a more extant time period. The main constraint is the unavailability of reliable morbidity and mortality measures for the Brazilian states that consider a larger period of time.

**5. References**


Alves, L. F. E Andrade, M. V. (2003). Impactos da Saúde nos Rendimentos Individuais no Brasil. *Revista de Economia Aplicada*. São Paulo.

Alves, L. F., Andrade, M. V. e Macedo, P. B. R. M. (2003). Health and Labor Market in Brazil (*mimeo*)

Anand, S. and Ravallion, M. (1993) “Human Development in Poor Countries: On the Role of Private Incomes and Public Services”, *Journal of Economic Perspectives* 7.

Barro, R. (1991) “Economic Growth in a Cross Section of Countries. “ *Quarterly Journal of Economic,s* 196 (2/May): 407–443.

Barro, R. (1996), “Health and Economic Growth”, Annex I of the “Convocatoria para propuestas de investigación sobre Inversión en Salud y Crecimiento Económico de la Organización Panamericana de la Salud.

Barro, R.J. e Lee, J, -W. (1993). International Comparisons of Educational attainment, Journal of Monetary Economics, vol. 32, pgs 363-394.

Bhargava, Alok. Jamison, Dean T. Lau, Lawrence, J. Murray, Christopher J. L. (2001) Modeling the effects of health on economic growth. Journal of Health Economics, n. 20, pgs 423–440.

Bloom, D. E., Canning, D. e Sevilla, J. (2001). The Effect Of Health On Economic Growth: Theory And Evidence. Cambridge: National Bureau of Economic Research. Working Paper 8587. 26pgs.

CELADE – Comisión Económica para América Latina y el Caribe. Estimaciones y Proyecciones de Población 1950-2050. [site na internet]. Disponível em http://www.eclac.cl/celade/proyecciones/intentoBD-2002.htm Acesso em 29/01/2004.

Cermeno, R. (2000). Education, Health And Growth: Panel Regressions For Latin America, Brazil, Colombia And México. In.: Mayer, D. Mora, H., Cermeño, R. Barona, A.B., Duryeau, S. (eds) (2000) Health, Growth and Income Distribution in Latin America and the Caribbean: a study of determinants and regional and local behavior. Research in Public Health Technical Papers, 18, Washington, DC.: Pan-American health Organization.

Cutler, David M. and Lleras-Muney, Adriana, "Education and Health: Evaluating Theories and Evidence" (July 2006). NBER Working Paper No. W12352

FALCÃO, B.L.S, SOARES, R.R. *The demographic transition and the sexual division of labor.* Stanford : Stanford Institute on International Studies, Center on Democracy, Development, and the Rule of Law. CDDRL , 2005. 37p (Working papers; 50)

Figueirêdo, Lízia de. The New Economic Geography and Regional Growth in Brazil and India. 2002. 570fls. (Thesis of Doctor of Philosophy), University of Nottingham, 2002.

Fogel, R. W. 1994. Economic Growth, Population Theory and Physiology: The Bearing of Long-Term Process on the Making of Economic Policy. American Economic Review 84 (3): 369-95.

Fujita, Masahisa; Krugman, Paul; e Venables, Anthony J. The Spatial Economy: cities, regions, and international trade. Cambridge, MIT: The MIT Press, 1999. 367pgs.

Fundação Getúlio Vargas – FGV. Conjuntura Econômica, 2000.

Howitt, P. (2005) Health, Human Capital, and Economic Growth: A Schumpeterian Perspective. In: López-Casanovas, G., Rivera, B. & Currais, L. (ed.) Health and Economic Growth. Cambride: The Mit Press.

Instituto Brasileiro de Geografia e Estatística (2001) - IBGE. Anuário Estatístico do Brasil, vários anos.

Instituto Brasileiro de Geografia e Estatística – IBGE. Censo Demográfico, 1991.

Instituto Brasileiro de Geografia e Estatística – IBGE. Censo Demográfico, 2000.

Instituto Brasileiro de Geografia e Estatística – IBGE. Diretoria de Pesquisas, Departamento de Contas Nacionais, Contas Regionais do Brasil 1985-2000. (CD-ROM).

Instituto Brasileiro de Geografia e Estatística – IBGE. Pesquisa Nacional por Amostra de Domicílio (PNAD), vários anos.

Instituto Brasileiro de Geografia e Estatística – IBGE. Censo Demográfico 2000: Fecundidade e Mortalidade Infantil. Resultados Preliminares da Amostra. IBGE. Rio de Janeiro, 2002.

Kassouf, A. L. Rendimentos perdidos por trabalhadores em condições inadequadas de saúde. Economia Aplicada. São Paulo, v. 3, n. 2, p. 239-262, 1999.

Knowles, S. and Owen, P. D. (1995), "Health Capital and Cross-country Variation in Income Per Capita in the Mankiw Romer Weil-Model", *Economics-Letters*, Vol. 48 (1), April, pp. 99-106.

Lucas, R.E. 1988, On the Mechanics of Economic Development, Journal of Monetary Economics, 22, pp. 3-42.

Mankiw, N. G.; Romer, D. and Weil, D. (1992), "A Contribution to the Empirics of Economic Growth", *Quarterly Journal of Economics*, May 1992, pp. 407-437.

Mayer, D. (2000). Health in the economic and demographic transition of Brazil, 1980-1995. In.: Mayer, D. Mora, H., Cermeño, R. Barona, A.B., Duryeau, S. (eds) (2000) Health, Growth and Income Distribution in Latin America and the Caribbean: a study of determinants and regional and local behavior. Research in

Public Health Technical Papers, 18, Washington, DC.: Pan-American health Organization.

Mayer, D. Mora, H., Cermeño, R. Barona, A.B., Duryeau, S. (2000) Health, Growth and Income Distribution in Latin America and the Caribbean: a study of determinants and regional and local behavior. Research in Public Health Technical Papers, 18, Washington, DC.: Pan-American health Organization.

Mora, H. e Barona, A. B. (2000). Health in the economic growth of Latin América. In.: Mayer, D. Mora, H., Cermeño, R. Barona, A.B., Duryeau, S. (2000) Health, Growth and Income Distribution in Latin America and the Caribbean: a study of determinants and regional and local behavior. Research in Public Health Technical Papers, 18, Washington, DC.: Pan-American health Organization.

Programa das Nações Unidas para o Desenvolvimento – PNUD. RELATÓRIO DO DESENVOLVIMENTO HUMANO 2002: Aprofundar A Democracia Num Mundo Fragmentado. New York: 2002, 288 pgs.

Romer, Paul M. (1986). “Increasing Returns and Long-Run Growth.” *Journal of Political Economy*, 94, 5 (October), pp. 1002-37.

Sachs, Jeffrey D. Macroeconomics and Health: Investing in health for Economic Development. Report of the Commission on Macroeconomics and Health. World Health Organization, 2001. 202 pp.

Sawyer O. D.; Wong, L.R., Carvalho J.A. M., Fígoli, M., Andrade F.C.D., Barbieri A. F. e Tavares C.R.G. (1999). Projeção Populacional, por Sexo e Grupos Qüinqüenais, das Unidades da Federação, Brasil, 1990-2020. Belo Horizonte: CEDEPLAR-UFMG. (Não publicado).

Solow, R.M., 1956, ’A Contribution to the Theory of Economic Growth’, Quarterly Journal of Economics, 70, pp. 65-94.

Thomas, D. and J. Strauss, 1997. “Health and wages: evidence on men and women in urban Brazil.” Journal of Econometrics, 77.

Zon, A. van, and J. Muysken, 1997, 'Health, Education and Endogenous Growth', Paper presented at the annual conference of the International Institute of Public Finance,Kyoto (1997), MERIT Research Memorandum, no. 97-009.